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ANDERSON ENGINEERING INC SPRINGFIELD MO
NATIONAL DAM SAFETY PROGRAM, LAKE SCIOTO DAM (MO 30097), MISSIS--ETC(U)
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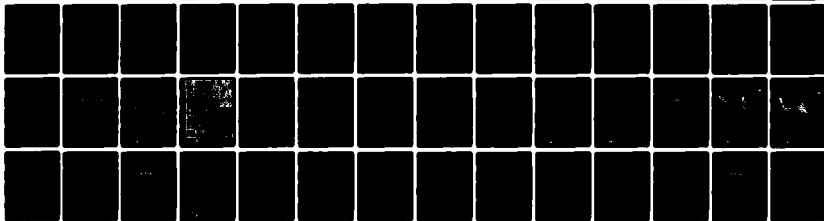
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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

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**LAKE SCIOTO DAM
PHELPS COUNTY, MISSOURI
MO 30097**

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**PHASE 1 INSPECTION REPORT
⑥ NATIONAL DAM SAFETY PROGRAM**

Lake Scioto Dam (MO 30097)
Mississippi - Kaskaskia - St. Louis River
Basin, Phelps County, Missouri. Phase I
Inspection Report.



**United States Army
Corps of Engineers**
... Serving the Army
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

9 Final rept.,

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10 Steve /Brady Tom /Beckley
Dave /Daniels Gene /Wertepny

11 AUG 1980

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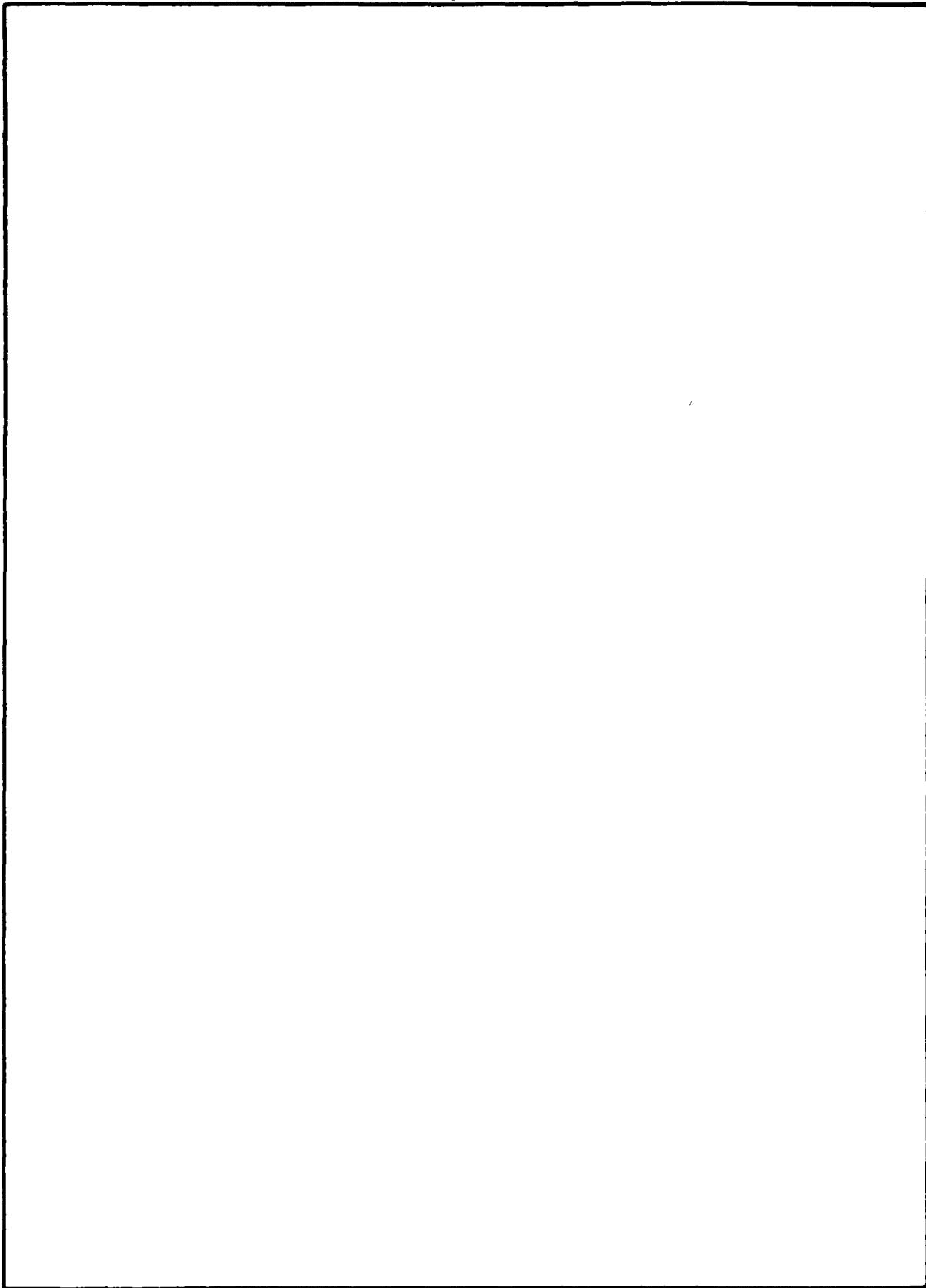
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REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Lake Scioto Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of Lake Scioto Dam (MO 30097).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

SUBMITTED BY:

Chief, Engineering Division

11 SEP 1980

Date

SIGNED

APPROVED BY:

Colonel, CE, District Engineer

11 SEP 1980

Date

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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

LAKE SCIOTO DAM
PHELPS COUNTY, MISSOURI
MISSOURI INVENTORY NO. 30097

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

August 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam:	Lake Scioto Dam
State Located:	Missouri
County Located:	Phelps
Stream:	Unnamed Tributary of Luther Branch Creek
Date of Inspection:	May 21, 1980

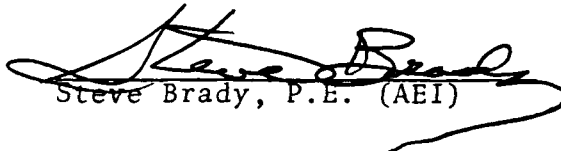
Lake Scioto Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri, and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately three miles downstream of the dam. Located within this zone are four dwellings and one building. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken. The dam is in the intermediate size classification, since it is greater than 40 ft high but less than 100 ft high.

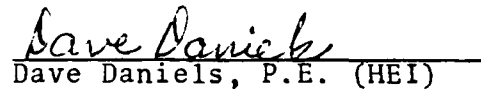
Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 38 percent of the Probable Maximum Flood (PMF) without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of intermediate size with a high downstream hazard potential pass 100 percent of the PMF. The 1 percent probability flood will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.

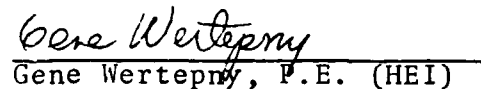
Deficiencies visually observed by the inspection team were: (1) a seepage area at the left abutment-dam contact; (2) minor erosion and sloughing of the upstream embankment face due to lack of wave protection; (3) minor undermining of the spillway outlet structure; and (4) scattered small tree and brush growth on the downstream embankment face. Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action promptly to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


Steve Brady, P.E. (AEI)


Tom Beckley, P.E. (AEI)


Dave Daniels, P.E. (HEI)


Gene Wertepny, P.E. (HEI)



AERIAL VIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE SCIOTO DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Lake Scioto Dam in Phelps County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Lake Scioto Dam is an earth fill structure approximately 44 ft high and 550 ft long at the crest. In this report, right and left orientation is based on looking in the downstream direction. The appurtenant works consist of a spillway consisting of four concrete-encased 24 in. diameter corrugated metal pipes, and an 8 in. diameter cast iron dewatering pipe. The spillway is located near the left abutment, and the dewatering pipe passes through the central portion of the embankment. A gravel road passes over the dam and the culvert spillway. Sheet 3 of Appendix A shows a plan, profile, and typical section of the embankment. Presented on Sheet 4 of Appendix A are a profile and section of the spillway.

B. Location:

The dam is located in the east central part of Phelps County, Missouri, on an unnamed tributary of Luther Branch Creek. The dam and lake are within the Meramec Springs,

Missouri, 7.5 minute quadrangle sheet (Section 30, T38N, R6W - latitude 37° 59.1'; longitude 91° 37.2'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 44 ft and a maximum storage capacity of approximately 174 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately three miles downstream of the dam. Located within this zone are four dwellings and one building. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken.

E. Ownership:

The dam is owned by the James Foundation (Mr. Ford Hughes, Local Supervisor). The owner's address is 320 South Bourbeuse, St. James, Missouri 65559 (telephone: 314-265-7124).

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes.

G. Design and Construction History:

Lake Scioto Dam was designed by the Missouri Department of Conservation in 1970. Plans for construction of the dam were obtained. However, the dam was constructed in a location 150 ft downstream from that shown on the plans. Information from the owner's representative indicates that this was done to avoid possible seepage problems associated with a large sandstone outcrop located in the left abutment at the original location (see the Engineering Geology Report, Sheets 3 and 4 of Appendix B). The design plans show a drop inlet primary spillway with an earth swale emergency spillway. The only spillway which was provided consists of four 24 in. diameter culverts. No drop inlet spillway was incorporated.

Borings were made by Mr. Emitt Dillon of St. James. The boring logs are unavailable. The dam was built in 1970 by Crawford Construction Company and Mr. Roy Dillon of St. James. Material for construction of the embankment was taken from the lake area (upper portions of the valley walls) and the right abutment area where there is presently a parking area. Mr. Hughes, local supervisor of the lake, reported that a cutoff trench was excavated about 4 to 6 ft deep. In addition, an 8 ft wide clay core of select material was incorporated into the embankment to within about 4 ft of the crest. No other zoning is known to exist.

A water main was constructed across the bottom of the lake (before initial filling) to an existing Boy Scout building on the left side. The exact location of this water main is unknown. The only reported post-construction change was the addition of material to the embankment crest after it settled approximately 1.5 ft. This was done about one year after the embankment was built. The roadway on the crest was also built at this time.

H. Normal Operating Procedures:

The normal flows are discharged through an uncontrolled culvert spillway located at the left abutment. Information from Mr. Ford Hughes, local supervisor of the lake, indicates that the maximum spillway discharge occurred in the spring of 1974, when the spillway pipes were about half full (water level about 3 ft from the top of the dam).

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 83 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 1,081.0): 96 cfs
- (3) Estimated Capacity of Spillway: 96 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: 28 cfs (Elev. 1,078.0)
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with a mean sea level (MSL) elevation of 1,080 for the corner of Sections 19, 20, 29, and 30 as shown on the Meramec Springs, MO quadrangle map).

- (1) Top of Dam: 1,081.0 (low point); 1,083.8 (high point)
- (2) Primary Spillway Crest: 1,076.6
- (3) Emergency Spillway Crest: None
- (4) Primary Outlet Pipe Invert: 1,076.6
- (5) Streambed at Centerline of Dam: 1,037.2
- (6) Pool on Date of Inspection: 1,076.6
- (7) Apparent High Water Mark: None apparent
- (8) Maximum Tailwater: Unknown
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 1,500 ft
- (2) At Primary Spillway Crest: 1,300 ft
- (3) At Emergency Spillway Crest: Not Applicable

E. Storage Capacities:

- (1) At Primary Spillway Crest: 130 acre-ft
- (2) At Top of Dam: 174 acre-ft
- (3) At Emergency Spillway Crest: Not Applicable

F. Reservoir Surface Areas:

- (1) At Primary Spillway Crest: 9 acres
- (2) At Top of Dam: 11.5 acres
- (3) At Emergency Spillway Crest: Not Applicable

G. Dam:

- (1) Type: Earth
- (2) Length at Crest: 550 ft
- (3) Height: 44 ft
- (4) Top Width: 14 ft
- (5) Side Slopes: Upstream 3.3H:1.0V (from crest to water's edge); Downstream varies (see Sheet 3, Appendix A)
- (6) Zoning: Apparently homogeneous except for select clay core
- (7) Impervious Core: 8 ft wide select clay core (information from Mr. Hughes)
- (8) Cutoff: 4 to 6 ft deep key trench (information from Mr. Hughes)
- (9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

- (1) Type: Not Applicable
- (2) Length: Not Applicable
- (3) Closure: Not Applicable
- (4) Access: Not Applicable
- (5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Primary Spillway:

- (1) Location: Left Abutment
- (2) Type: Four 24 in. diameter concrete-encased corrugated metal pipe culverts

I.2 Emergency Spillway:

- (1) Location: Not Applicable
- (2) Type: Not Applicable

J. Regulating Outlets:

The drawdown facilities consist of an 8 in. diameter steel pipe with a valve on the downstream end near the embankment toe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

The dam was designed by the Missouri Department of Conservation in 1970. Plans for construction of Lake Scioto Dam were obtained. These plans show typical embankment sections, plans, profiles, and details of the spillway intake and dewatering structure. However, the locations of the dam and spillway were changed, as was the type of spillway. Therefore, the design plans are not representative of the dam which was constructed. No as-built plans are available.

A. Surveys:

The design plans include a topographic map of the area prepared from a site survey. However, the dam was not constructed in the location shown on the plans.

Sheet 3 of Appendix A presents a plan, profile, and cross section of the dam from survey data obtained during the site inspection. The monument at the corner of Sections 19, 20, 29 and 30 was used as a reference point to determine all elevations. A mean sea level (MSL) elevation of 1,080 (as shown on the U.S.G.S. topographic map) was used for this datum.

B. Geology and Subsurface Materials:

The site is located in the north-central portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus, and deep valleys. The most common bedrock types are dolomite, sandstone, and chert. The "Geologic Map of Missouri" indicates that the bedrock in the site area consists primarily of undifferentiated shales and sandstones of the Pennsylvanian System. Valley areas near the site contain the Jefferson City formation of the Canadian Series of the Ordovician System. The Jefferson City formation is composed principally of light brown to brown, medium to finely crystalline dolomite and argillaceous dolomite. The average thickness of the Jefferson City is 200 ft.

The engineering geology report prepared by the Missouri Geological Survey in 1969 (Sheets 3 and 4, Appendix B) describes the bedrock conditions at the site and recommends further subsurface investigations for foundation conditions and borrow sources.

The publication "Caves of Missouri" indicates that at least 56 caves exist in Phelps County. Although the majority of these caves are located in the western half of Phelps County, there are a few caves located south and southeast of the site within 10 miles.

The "Geologic Map of Missouri" indicates a normal fault passing about 10 miles east of the site in a north-south direction. The Missouri Geological Survey has indicated that the faults in this area are considered to be inactive and have been for several hundred million years.

Information from the Soil Conservation Service indicates that the soils in the watershed area of Lake Scioto are comprised of the following soil types:

<u>Soil (Slopes)</u>	<u>Percent of Watershed</u>
Lebanon (3-5%)	25
Beemont (9-14%)	11
Gerald (0-2%)	64

The Lebanon soils consist of a brown silt loam above fragipan, with generally more than 5 ft to bedrock. The Gerald soils are brownish gray silt loams over gray and red cherty subsoils. No information about the Beemont soils was obtained.

C. Foundation and Embankment Design:

Borings were made along the proposed centerline of the embankment prior to construction. The results of these borings were unavailable. The design plans call for an 8 ft wide cut-off trench below the dam. The owner's representative indicated that a 4 ft to 6 ft deep cutoff trench was incorporated, and that an 8 ft wide core of select clayey material was built to within 4 ft of the top in the center of the dam. Embankment slopes are shown as 3 horizontal to 1 vertical. Concrete anti-seep collars are shown around the spillway pipe. It is not known if anti-seep collars were installed around the draw-down pipe.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design computations for this dam were available. Based on a field check of spillway dimensions and embankment elevations, and a check of the drainage area on the U.S.G.S. topographic map, hydrologic analyses using U. S. Army Corps of Engineers' guidelines were performed and appear in Appendix C, Sheets 1 to 9.

E. Structure:

No structural design data for the spillway or drawdown valve box were available.

2.2 CONSTRUCTION:

No construction inspection data were available.

2.3 OPERATION:

Normal flows are passed by an uncontrolled culvert spillway located near the left abutment. An 8 in. diameter steel pipe and valve are provided to dewater the lake. Mr. Hughes indicated that the lake has never been drained, but the valve is opened periodically. The valve was last opened about two years ago.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available. The design plans do not represent the dam which was constructed.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on May 21, 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam embankment appears to be in good condition. There is no wave protection for the upstream embankment face, and some sloughing and minor erosion was noted. The embankment crest is clear and fairly level. A gravel road passes along the crest. The dam was constructed slightly concave downstream (see Photos 2 and 3). The downstream embankment face is clear except for some widely scattered small tree and brush growth. A seepage area was observed at the left abutment-dam contact (see Sheet 4, Appendix A). Although no seepage flows were noted, the area was wet and soft, with cattail growth (see Photo 8). Sheet 5 of Appendix A presents a plan sketch of the dam showing observed features.

Shallow auger probes into the embankment indicated the dam to consist of a reddish brown silty clay to clayey silt (CL). Information from Ford Hughes indicates that material for construction of the dam was obtained from the lake area (upper portions of the valley walls) and from the right abutment.

C. Appurtenant Structures:

C.1 Primary Spillway:

The approach to the spillway is clear with the exception of some minor silting and cattail growth (see Photo 9). The spillway pipes and surrounding concrete are in good condition. Some minor undermining of the concrete bridge structure was noted at the downstream end of the spillway pipes (see Photos 11 and 12). This undermining extended about 6 in. to 12 in. under the structure. The spillway outlet channel contains dumped riprap and concrete debris and is fairly clear for

about 75 ft. Beyond, the channel is lined with tree and brush growth. Sandstone and dolomite bedrock outcrops were noted in the outlet channel (see Photo 13). The outlet channel is well away from the dam, and spillway releases would not damage the embankment.

C.2 Emergency Spillway:

There is no emergency spillway associated with this dam.

C.3 Drawdown Pipe:

The 8 in. diameter cast iron drawdown pipe and valve appeared to be in good condition. A concrete box encloses the valve (see Photos 14 and 15). The box is normally kept locked.

D. Reservoir:

The watershed contains residential areas in the upper portion, with wooded and grassy areas adjacent to the lake. The slopes adjacent to the reservoir are gentle, and no sloughing or serious erosion was noted. No evidence of significant sedimentation was observed.

E. Downstream Channel:

The downstream channel is lined with tree growth below the drawdown pipe outlet (see Photo 15).

3.2 EVALUATION:

The wave erosion and sloughing on the upstream embankment face, the seepage at the left abutment-dam contact, and the undermining of the spillway structure could worsen and adversely affect the stability of the dam. These deficiencies should be corrected under the direction of an engineer experienced in the design and construction of dams.

Because the valve of the lake drain is located on the downstream side of the dam, the full head of water impounded by the dam is acting entirely through the dam. The area around the lake drain outlet should be periodically inspected for seepage which might indicate a leak or rupture of the drain pipe and could eventually initiate a piping failure through the embankment.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

The reservoir pool is normally controlled by rainfall, runoff, evaporation, the capacity of the uncontrolled spillway, and seepage from the reservoir. An 8 in. diameter steel pipe and valve are provided to dewater the lake.

4.2 MAINTENANCE OF DAM:

The wave erosion and sloughing on the upstream embankment face, scattered small tree and brush growth on the downstream face, and undermining of the spillway structure will require some maintenance.

4.3 MAINTENANCE OF OPERATING FACILITIES:

Although the lake has never been dewatered, the valve is operated periodically. The valve was last opened about 2 years ago. It is unknown if the drawdown pipe valve has required maintenance.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The undermining of the spillway, seepage area and scattered tree and brush growth on the downstream face, and erosion and sloughing of the upstream face due to lack of wave protection are deficiencies which should be corrected.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. Mr. Hughes reported that the dam has never overtopped. The maximum spillway discharge occurred in the spring of 1974, when the spillway pipes were flowing about half full (water level about 3 ft below the top of the dam).

C. Visual Observations:

The approach to the spillway is fairly clear. The right portion of the outlet end of the spillway structure is undermined for 6 in. to 12 in. The outlet channel is fairly clear and either protected by riprap or eroded into bedrock. Spillway releases would not be expected to endanger the dam.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U.S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevations; and (2) an estimate of the reservoir storage and the pool and drainage areas from the Maramec Springs, Missouri, 7.5 Minute U.S.G.S. quad sheet.

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 38 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass 100 percent of the PMF, without overtopping. The spillway will pass the 1 percent probability flood without overtopping the dam.

Application of the Probable Maximum Precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 1,871 cfs. For 50 percent of the PMP, the peak inflow was 936 cfs.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.2 ft at elevation 1,082.2. The duration of the overtopping will be 5.8 hours, and the maximum outflow will be 1,593 cfs. The maximum discharge capacity of the spillway is 96 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 0.5 ft at elevation 1,081.5. The maximum outflow will be 405 cfs, and the duration of overtopping will be 3.3 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

The only available design data were plans for construction prepared by the Missouri Department of Conservation in 1970. However, the locations and configurations of the embankment and appurtenances were changed, and the dam was not constructed according to the design plans. No construction data were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The only reported post-construction change was the addition of fill to level the embankment after it had settled about 1.5 ft. The road across the crest was then constructed.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected, or controlled. These items are: (1) a seepage area at the left abutment-dam contact; (2) minor erosion and sloughing on the upstream embankment face due to lack of wave protection; (3) minor undermining of the spillway outlet structure; and (4) scattered brush and small tree growth on the downstream embankment face. Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 38 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by the owner's representative, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will deteriorate and possibly could become serious in the future. The item recommended in paragraph 7.2A should be pursued promptly.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no additional inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

- (1) Spillway size and/or height of dam should be increased to pass 100 percent of the PMF. In either case, the spillway should be protected to prevent erosion.

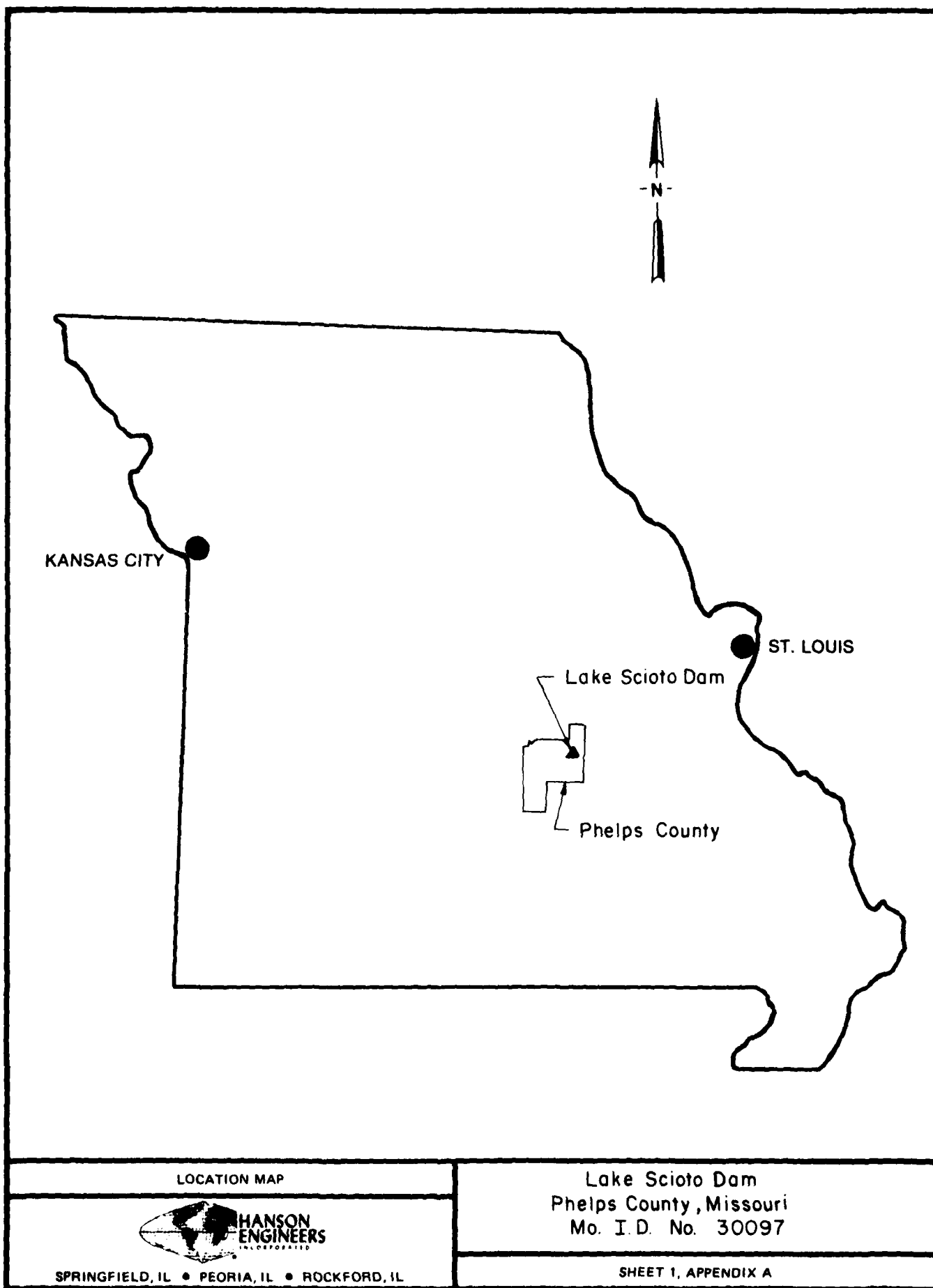
B. O&M Procedures:

- (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.
- (2) The erosional areas and sloughs should be repaired, and wave protection should be provided for the upstream embankment face.
- (3) The seepage area noted at the left abutment-dam contact should be investigated by an engineer experienced in the design and construction of dams. Remedial measures may be required. As a minimum, these areas should be inspected periodically in an effort to detect an increase in the quantity of seepage or any indication that soil particles are being carried by the water. In this event, an experienced engineer should be contacted immediately.

- (4) Tree and brush growth should be removed on an annual basis. This should be done under the guidance of an engineer experienced in the design and construction of dams.
- (5) The undermining of the spillway outlet should be repaired, and the structure should be protected against future undermining.
- (6) The valve on the drawdown pipe should be opened periodically to insure that it is operable.
- (7) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans





VICINITY MAP



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Scioto Dam
Phelps County, Missouri
Mo. I.D. No. 30097

Sheet 2, Appendix A

- 1+00 -

0+00 -

1+00 -

2+00 -

3+00 -

1086.1

1083.3

1083.8

1084.8

1082.1

1080.2

1088.7

1081.5

1082.0

1081.5

1081.1

1081.2

1081.8

1081.0

1081.2

1080.7

1067.3

TOE OF SLOPE

INVERT 8" PIPE
ELEV. = 1038.4

1031

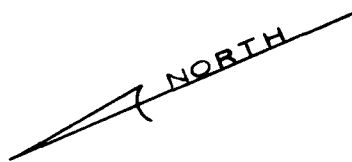
PLAN
SCALE: 1"

L A K E

A

A

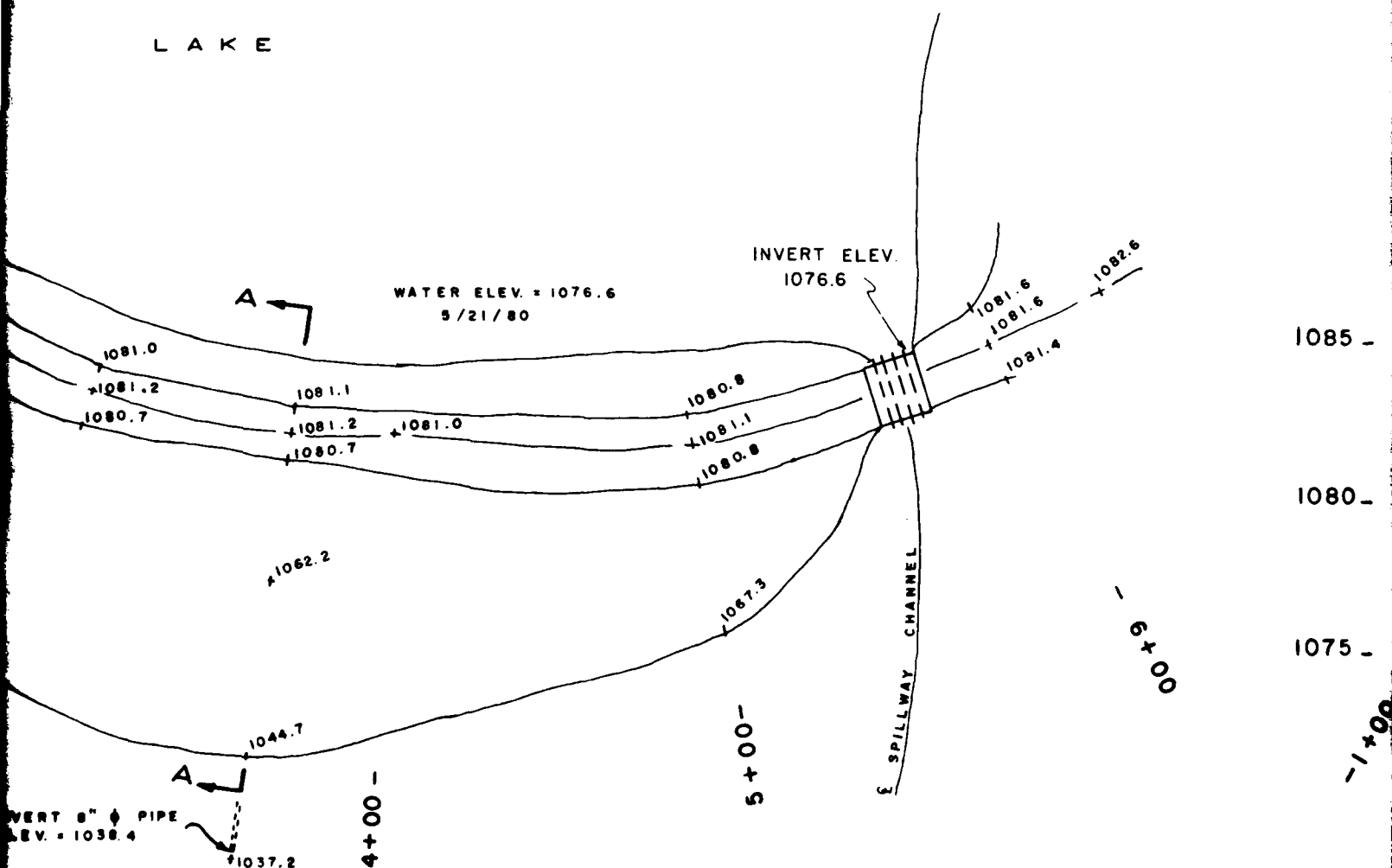
2



PLAN VIEW

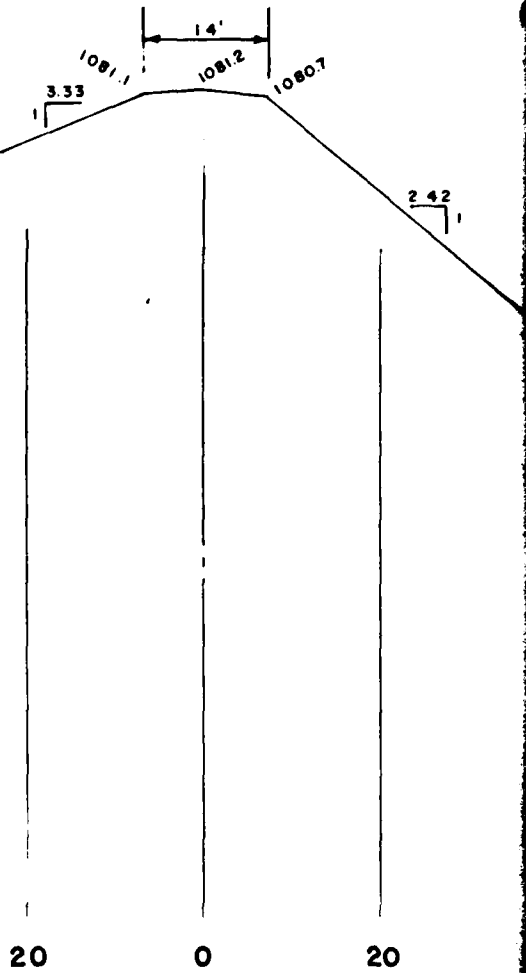
SCALE: 1" = 50'

LAKE

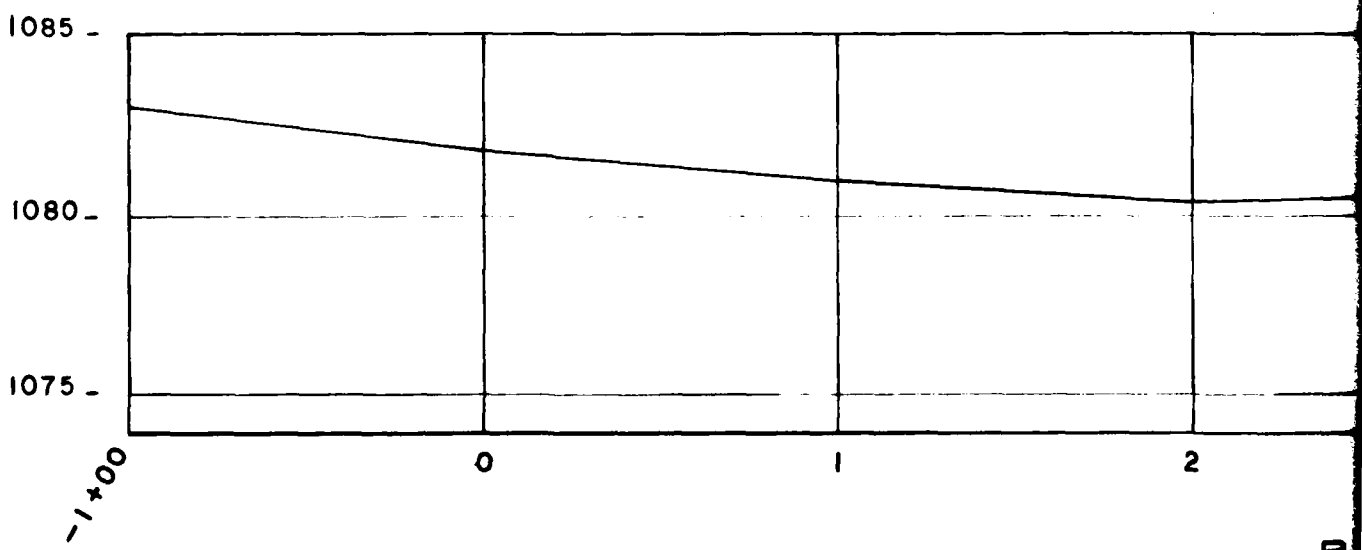


3

WATER SURFACE
ELEV = 1076.6



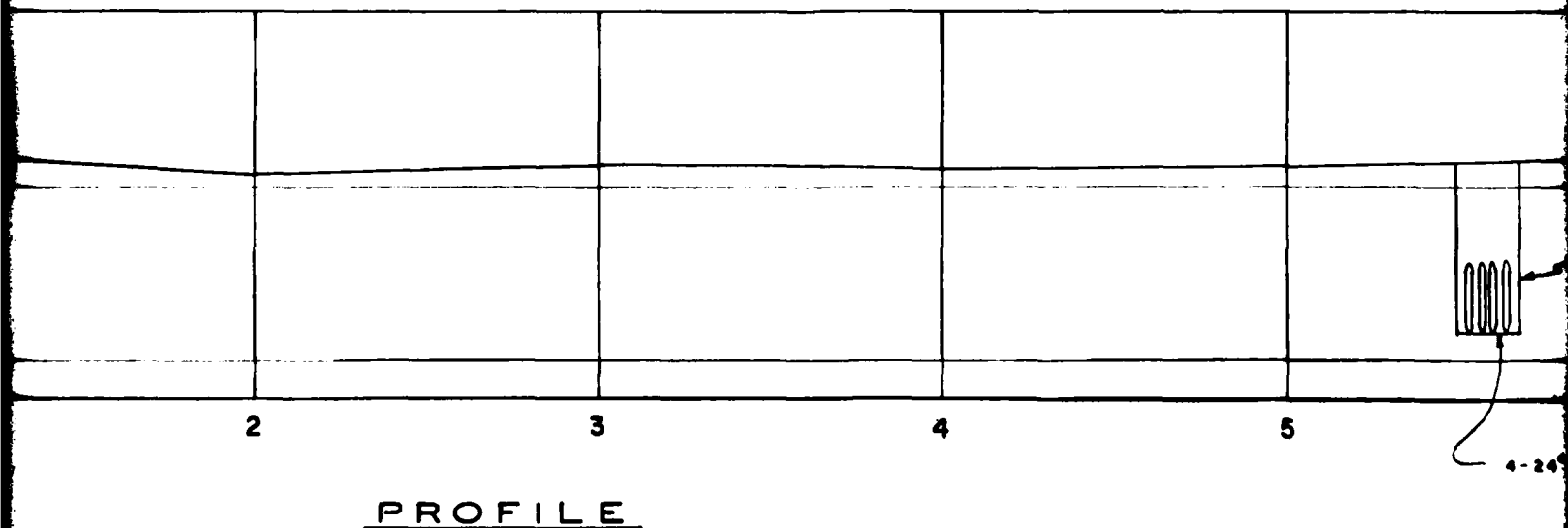
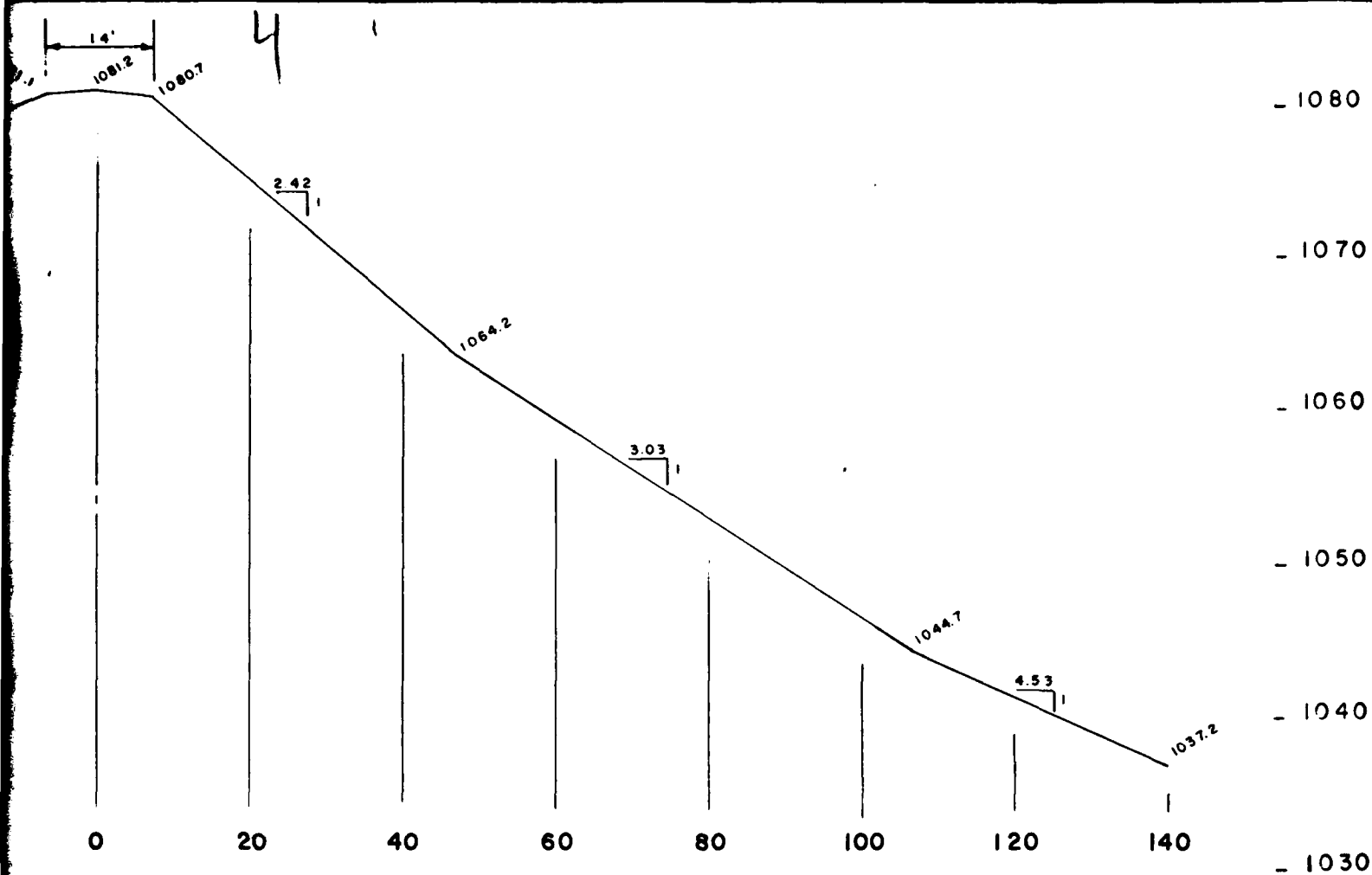
SECTION



+1082.6

-1+00

2



5

- 1080

- 1070

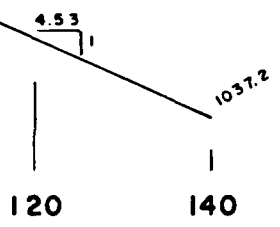
- 1060

- 1050

- 1040

- 1030

Elevation (ft, MSL)



- 1085

- 1080

- 1075

Elev. (ft, MSL)

CONCRETE CULVERT

4-24" ϕ PIPES

6x50

SHEET 3 APPENDIX A

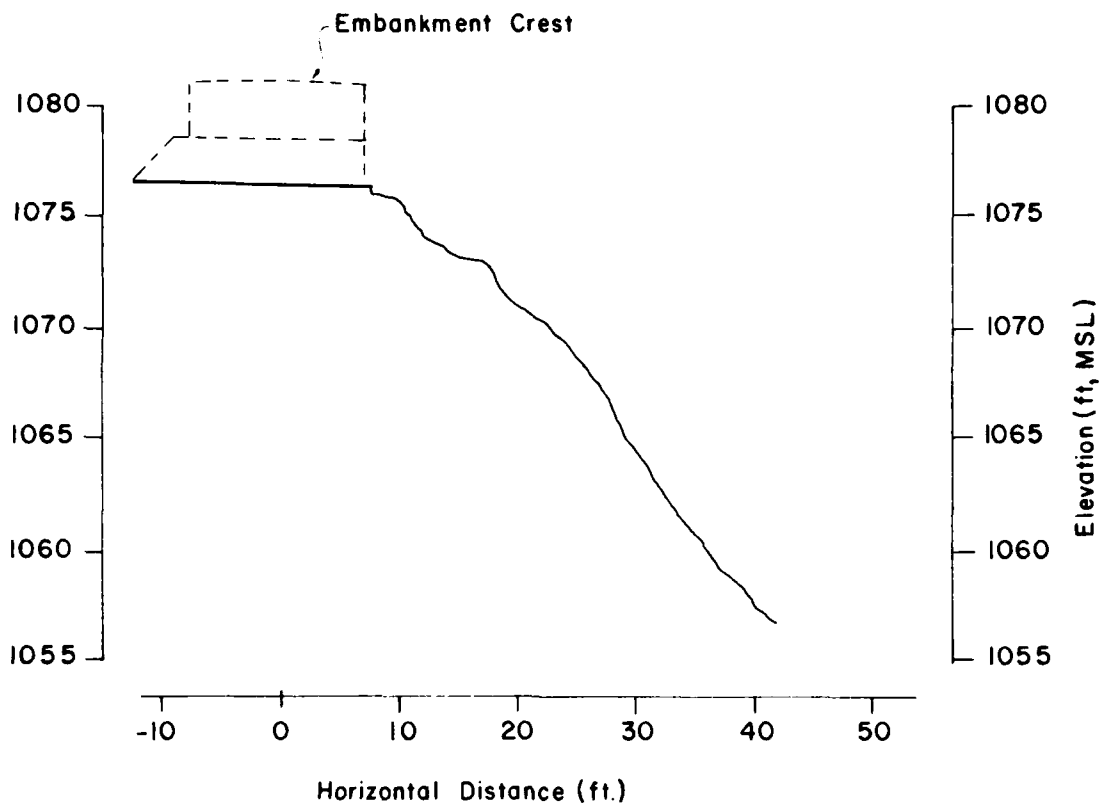
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

LAKE SCIOTO DAM

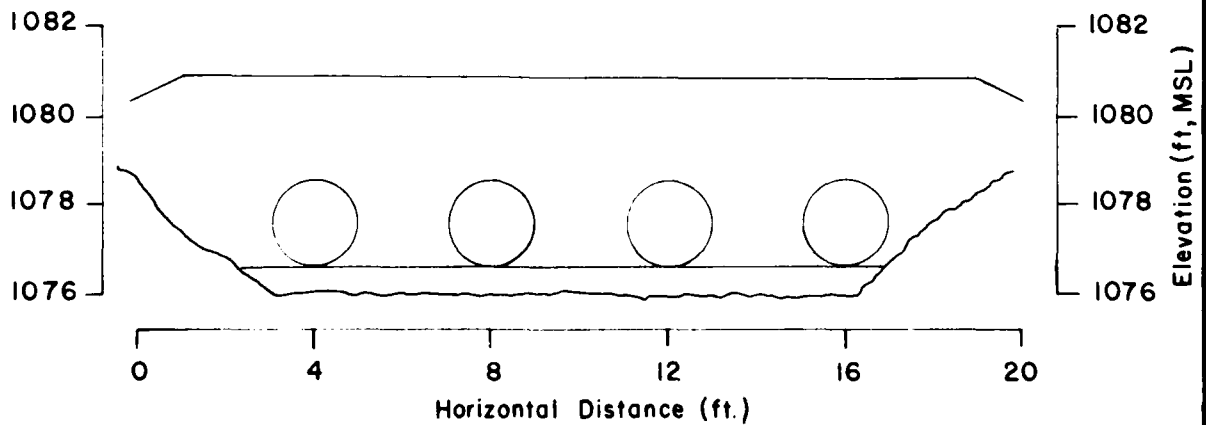
MO. No. 30097

PLAN & PROFILE

PHELPS COUNTY, MO.



SPILLWAY PROFILE



SPILLWAY CROSS-SECTION

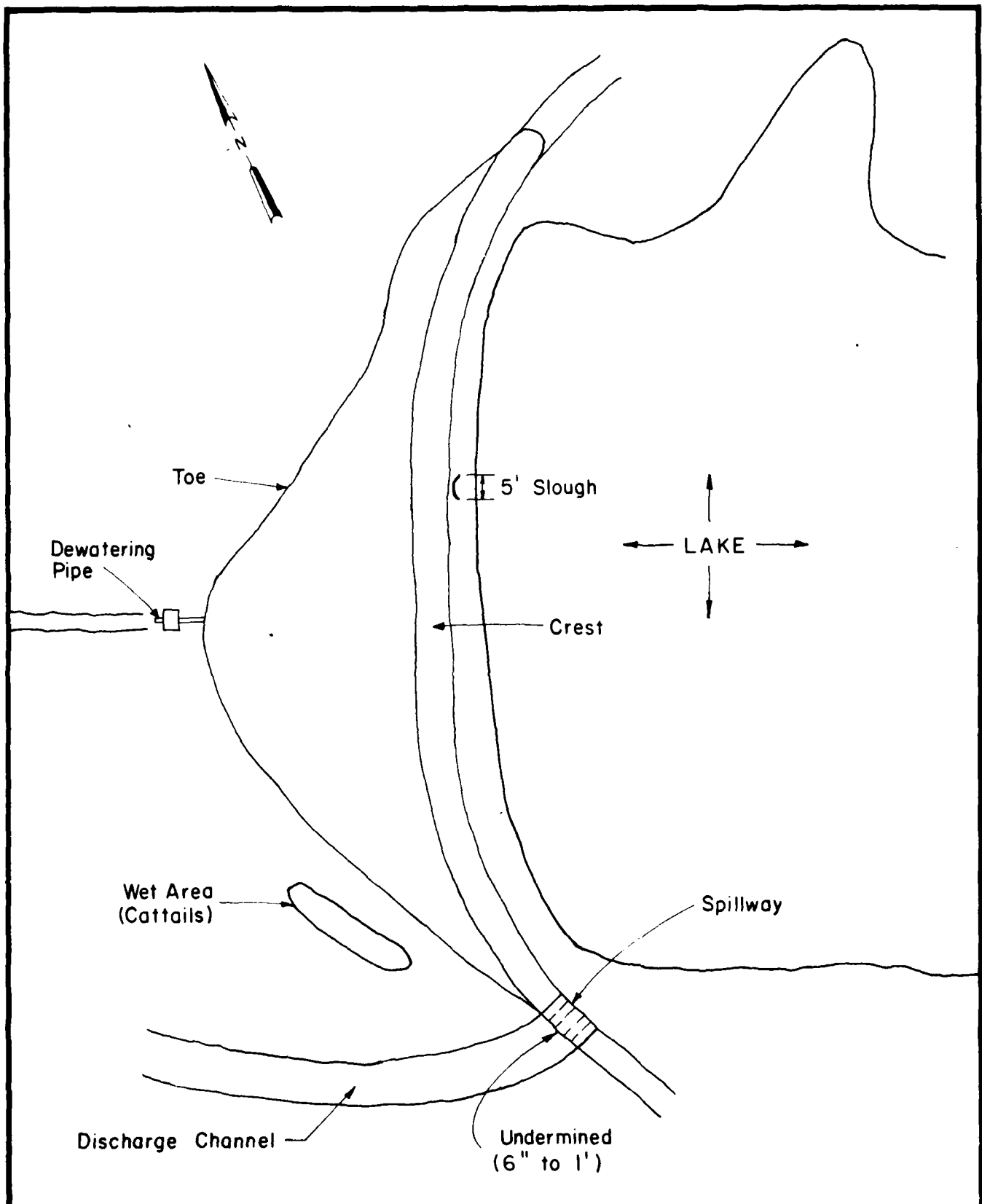
PLAN & SECTION OF SPILLWAY



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Scioto Dam
Phelps County, Missouri
Mo. I.D. No. 30097

Sheet 4, Appendix A



PLAN SKETCH OF FEATURES



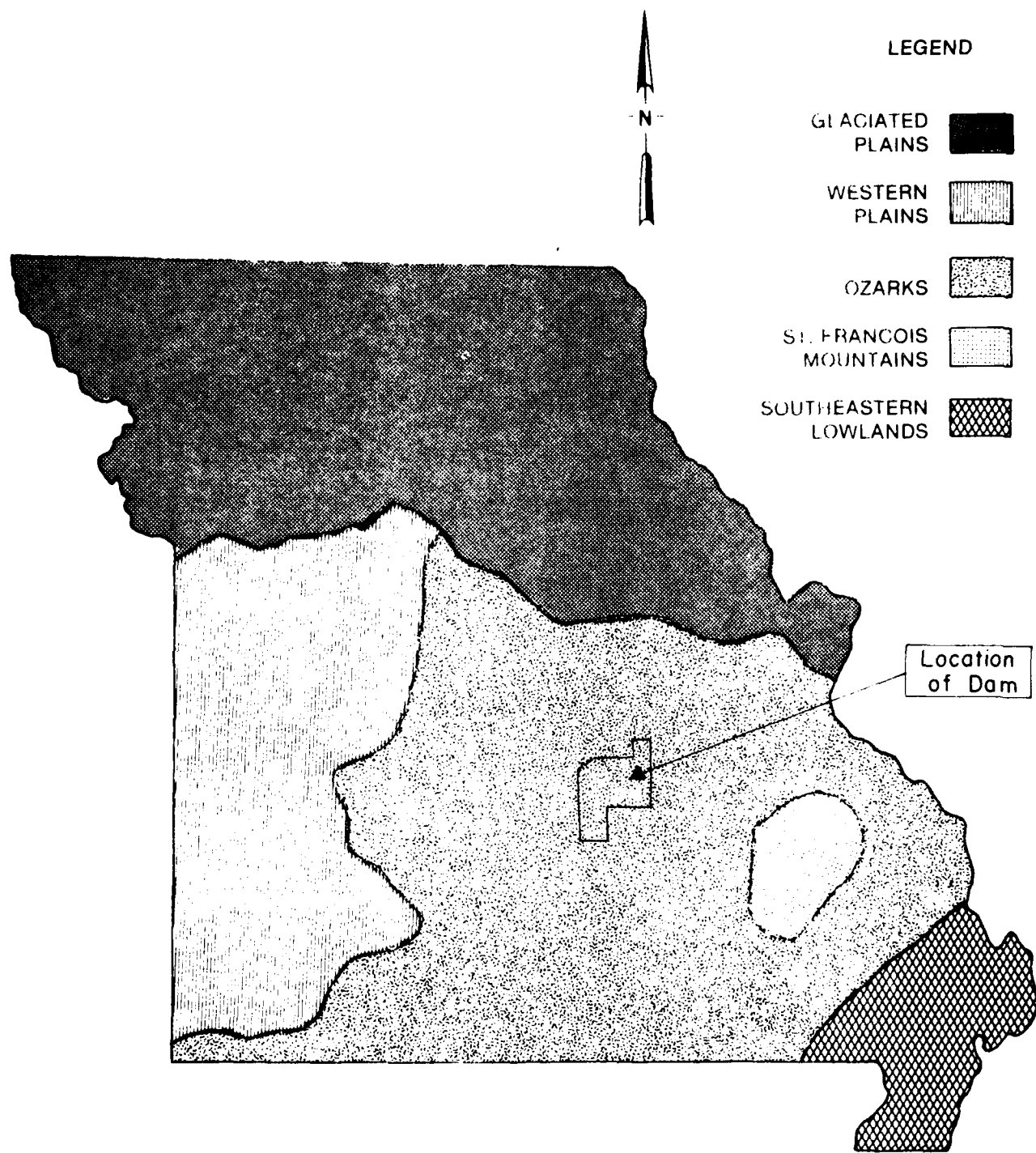
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Scioto Dam
Phelps County, Missouri
Mo. I.D. No. 30097

Sheet 5, Appendix A

APPENDIX B

Geology and Soils



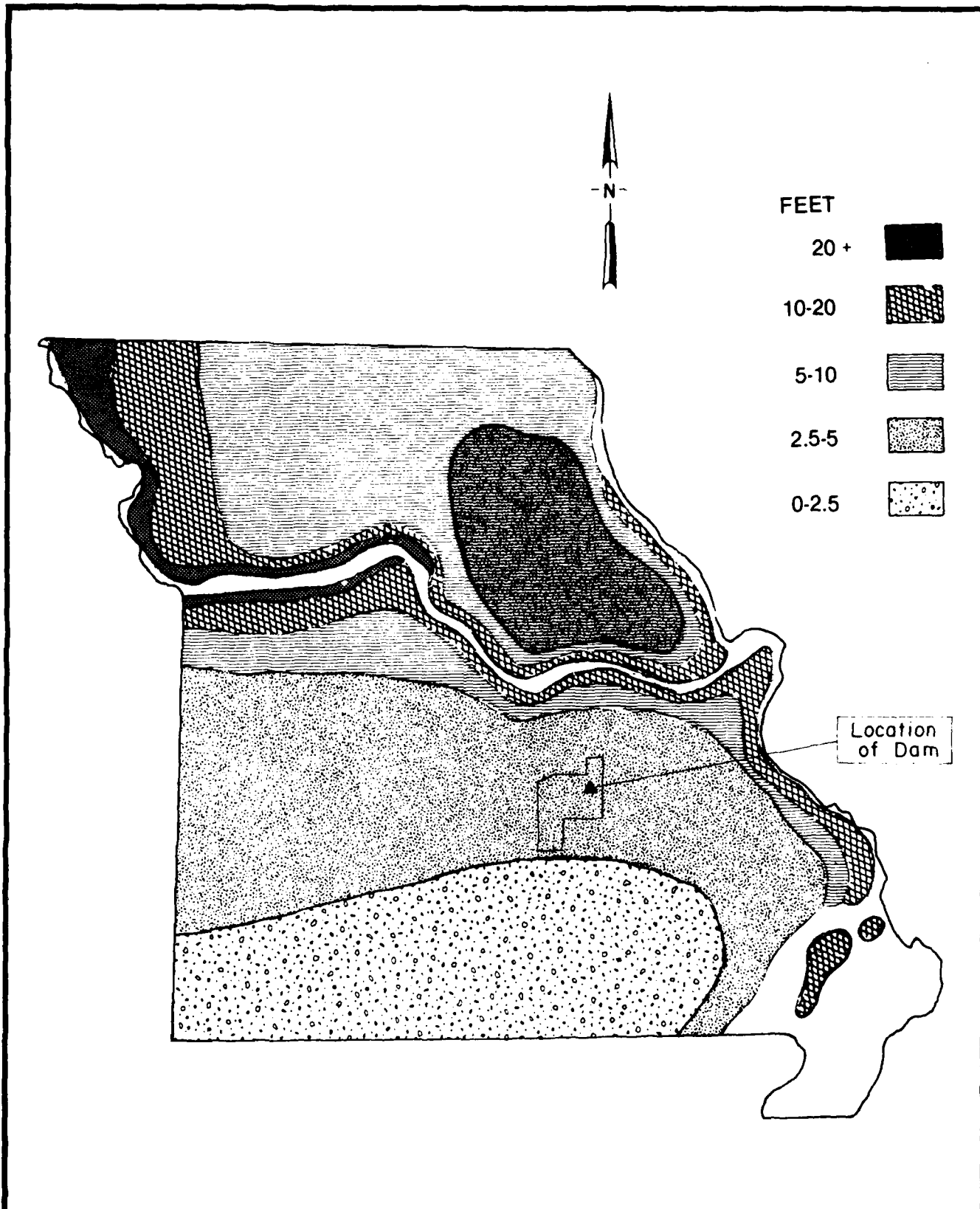
MAJOR GEOLOGIC REGIONS OF MISSOURI



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Scioto Dam
Phelps County, Missouri
Mo. I.D. No. 30097

SHEET 1, APPENDIX B



Eng Geol
Reservoir

ENGINEERING GEOLOGY OF THE ST. JAMES PARK LAKE, HELPS COUNTY

LOCATION: NE NE NE sec. 30, T.38 N., R.6 W. (Meramec Springs Quad.)

The proposed lake site is situated in a small tributary valley of Luther Branch Creek. The lake site area and a large portion of the drainage area is blanketed by residual clays and sandstones of Pennsylvanian age. The Jefferson City Dolomite can be seen cropping out in the stream valley several hundred feet upstream of the proposed dam site.

The drainage area encompasses approximately 100 acres and should be sufficient drainage to provide a relatively stable waterline in a lake 5 to 10 acres in size provided no adverse leakage conditions are encountered.

Surficial investigation at the dam site revealed dolomite bedrock cropping out at or near the elevation of the present stream bed. The abutments at the dam site are composed of the most part of shales and sandstones of Pennsylvanian age. A rather large block of sandstone can be seen cropping out at the right abutment. Generally the Pennsylvanian rocks provide a very stable and impermeable barrier to the percolation of water. The presence, however of this rather large isolated block of sandstone at the abutment could cause serious water loss around the abutment. If this large sandstone block is isolated, as it appears to be, water may be transmitted both through and around this feature. The topographic nose just downstream of this large sandstone block is highly weathered and may be subject to rapid water intake under pressure if the abutment is put there.

It is not thought at this time that the bedrock exposed several hundred feet upstream of the proposed dam will cause any substantial water loss.

No potential borrow areas were located during a surficial investigation. The ridgetops on both sides of the valley have bedrock exposed near the surface and it is not thought at this time that substantial amounts of silty clay borrow material will be available.

RECOMMENDATIONS:

It is recommended that a drilling program be set up to determine the depth to and condition of bedrock on the proposed centerline of the dam. The clayey dolomite of the Jefferson City Formation can carry substantial amounts of water through bedding planes 5 to 6 feet below the surface. These bedding planes will necessarily have to be intercepted by a core trench to cut off this laterally moving water which would normally travel underneath the dam. This drilling program can also be used to locate potential borrow areas. Borrow material may have to be trucked in from other areas if none is found at the site. It is recommended that the drilling program also be carried out on the right abutment to determine the porosity and the weathering characteristics of the abutment material.

It is recommended that no borrow material be obtained below the waterline in the lake area. The natural sealant material is the best protection against both lateral and vertical percolation of water into the bedrock.

If a drilling program determine that the porosity of the weathered right abutment is too great or the core trench may have to be too deep to be economically

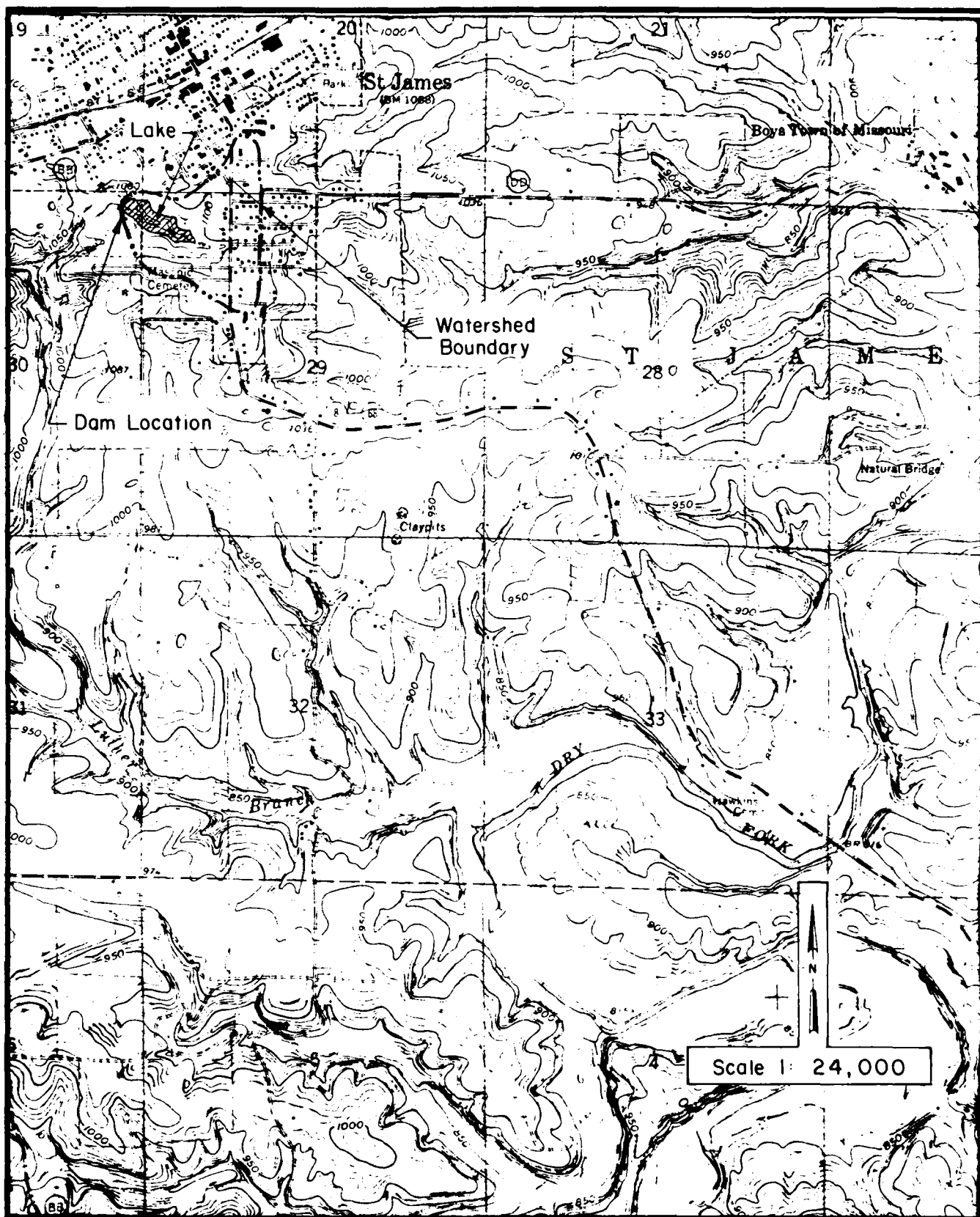
St. James Park Lake, Phelps County

feasible in the valley bottom, the proposed dam should be moved upstream at least 100 feet.

Thomas J. Dean
Engineering Geologist
Missouri Geological Survey
February 18, 1969

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Scioto Dam
Phelps County, Missouri
Mo. I.D. No. 30097

Sheet I, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC OVERTOPPING ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. Sullivan rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The parameters for the unit hydrograph are shown in Table 1 (Sheet 3, Appendix C).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the results from the computer output, are shown in Table 2 (Sheet 4, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method assuming the starting reservoir elevation at normal pool. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area--storage-discharge relationships shown in Table 3 (Sheet 4, Appendix C).

The rating curve for the spillway (see Table 4, Sheet 5, Appendix C) was determined assuming charts for corrugated metal pipe with entrance control and full flow control, from the U.S. Bureau of Public Roads.

The flow over the crest of the dam during overtopping was determined using the non-level dam option (\$L and \$V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 6, Appendix C).

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 7, 8 and 9 of Appendix C.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	0.13 sq. miles
Length of Watercourse (L)	0.34 miles
Difference in elevation (H)	38 feet
Time of concentration (Tc)	0.18 hours
Lag Time (Lg)	0.11 hours
Time to peak (Tp)	0.15 hours
Peak Discharge (Qp)	420 cfs
Duration (D)	5 min.

<u>Time</u> (Min.)(*)	<u>Discharge</u> (cfs)(*)
0	0
5	235
10	413
15	213
20	87
25	35
30	14
35	6
40	3
45	0

(*) From the computer output

FORMULA USED:

$$T_c = \left(\frac{11.9 L^3}{H} \right)^{0.385}$$

From California Culverts Practice, California
Highways and Public Works, September 1942.

$$L_g = 0.6 T_c$$

$$T_p = \frac{D}{2} + L_g$$

$$Q_p = \frac{484 A \cdot Q}{T_p} \quad Q = \text{Excess Runoff} = 1 \text{ inch}$$

TABLE 2
RAINFALL-RUNOFF VALUES

<u>Selected Storm Event</u>	<u>Storm Duration (Hours)</u>	<u>Rainfall (Inches)</u>	<u>Runoff (Inches)</u>	<u>Loss (Inches)</u>
PMP	24	33.80	32.07	1.73
1 % Prob. Flood	24	7.23	4.32	2.91

Additional Data:

- 1) Soil Conservation Service Soil Group B
- 2) Soil Conservation Service Runoff Curve CN = 85 (AMC III) for the PMF
- 3) Soil Conservation Service Runoff Curve CN = 70 (AMC II) for the
1 percent probability flood
- 4) Percentage of Drainage Basin Impervious 15 percent

TABLE 3
ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

<u>Elevation (feet-MSL)</u>	<u>Lake Surface Area (acres)</u>	<u>Lake Storage (acre-ft)</u>	<u>Spillway Discharge (cfs)</u>
1050.0	1.8	2	-
1060.0	3.7	29	-
1070.0	6.4	79	-
*1076.6	9.0	130	0
1080.0	10.4	163	84
**1081.0	11.5	174	96
1085.0	15.9	229	140
1090.0	21.4	322	-

*Primary spillway crest elevation

**Top of dam elevation

The above relationships were developed using the MARAMEC SPRINGS, MO
7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

<u>Reservoir Elevation (ft, MSL)</u>	<u>Spillway Discharge (cfs)</u>
1076.6	0
1077.6	16
1078.0	28
1078.6	44
1079.6	72
1080.0	84
*1081.0	96
1083.0	120
1085.0	140

*Top of dam elevation

METHOD USED:

Charts for corrugated-metal pipes with entrance and full flow control from the U. S. Bureau of Public Roads were used.

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*1076.6	130	0	-
0.10	187	1077.9	143	25	-
0.20	374	1079.1	154	58	-
0.25	468	1079.7	160	73	-
0.30	561	1080.3	166	83	-
0.35	655	1080.8	172	93	-
0.38	711	**1081.0	174	96	0
0.40	749	1081.2	177	123	0.2
0.50	936	1081.5	181	405	0.5
0.75	1403	1082.0	188	1163	1.0
1.00	1871	1082.2	190	1593	1.2

The percentages of the PMF that will reach the top of the dam is 38 percent.

*Primary spillway crest elevation

**Top of dam elevation

A OVERTOPPING ANALYSIS FOR LAKE SCIOTO DAM (# 20)
 A STATE ID NO. 30097 COUNTY NAME : PHELPS
 A HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 8083001
 B 300 5
 B1 5
 J 1 9 1
 J1 .10 .20 .25 .30 .35 .40 .50 .75 1.0
 K 0 1 3 1
 K1 INFLOW HYDROGRAPH COMPUTATION **
 M 1 2 0.13 0.13 1
 P 0 26.0 102 120 130
 T -1 -85 0.15
 U2 0.18 0.11
 X 0 -.1 2
 K 1 2 0 4 1
 K1 RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **
 Y 1 1
 Y1 1
 Y41076.6 1077.6 1078.6 1079.6 1081.0 1083.0 1085.0
 Y5 0 16 44 72 96 120 140
 S 0 29 79 130 163 174 229
 SE 1048 1060 1070 1076.6 1080 1081 1085
 S1076.6
 SD 1081
 SL 0 120 330 460 520 580 620 710 800 900
 SV 1081 1081.1 1081.2 1081.6 1082.0 1082.6 1083.0 1083.8 1085.0 1086.0
 K 99

PMF RATIOS
 INPUT DATA
 Sheet 7, Appendix C

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				0.10	0.20	0.25	0.30	0.35	0.40	0.50	0.75	1.00
HYDROGRAPH AT	1	0.13	1	187.	374.	468.	561.	655.	749.	936.	1403.	1871.
	(	0.34)	(	5.30)	10.60)	13.25)	15.90)	18.55)	21.20)	26.49)	39.74)	52.99)
ROUTED TO	2	0.13	1	25.	58.	73.	83.	93.	123.	405.	1163.	1593.
	(	0.34)	(	0.71)	1.64)	2.07)	2.36)	2.63)	3.49)	11.46)	32.94)	45.11)

SUMMARY OF DAM SAFETY ANALYSIS

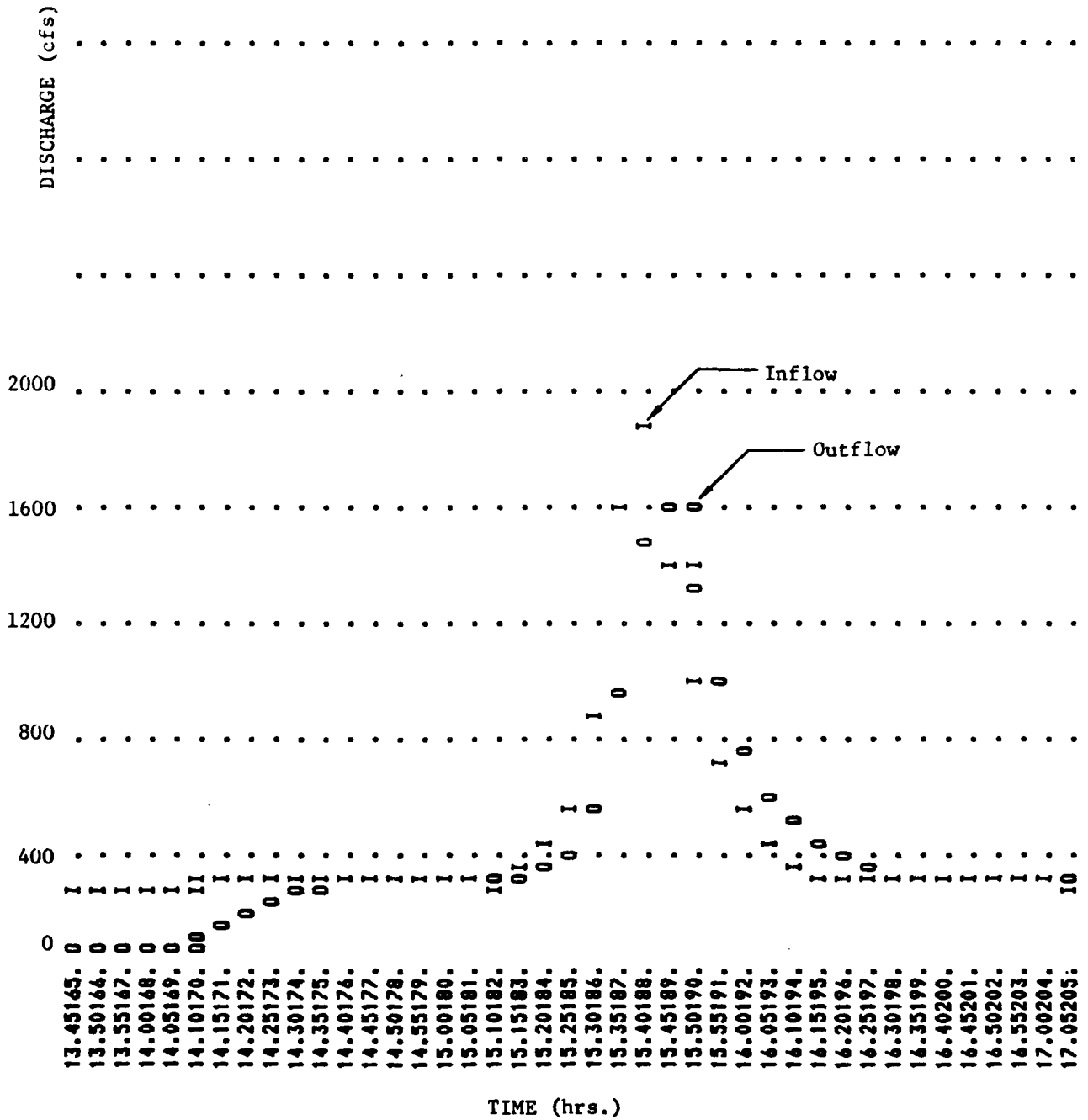
PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	STORAGE	1076.60	1076.60	1081.00
	OUTFLOW	130.	130.	174.
		0.	0.	96.

PMF RATIOS
OUTPUT DATA
Sheet 8, Appendix C

RATIO OF PMF	MAXIMUM RESERVOIR U.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	1077.93	0.00	143.	25.	0.00	17.25	0.00
0.20	1079.10	0.00	154.	58.	0.00	17.08	0.00
0.25	1079.67	0.00	160.	73.	0.00	17.08	0.00
0.30	1080.26	0.00	166.	83.	0.00	17.17	0.00
0.35	1080.82	0.00	172.	93.	0.00	17.17	0.00
0.40	1081.19	0.19	177.	123.	2.75	17.00	0.00
0.50	1081.53	0.53	181.	405.	3.33	15.92	0.00
0.75	1082.00	1.00	188.	1163.	4.58	15.75	0.00
1.00	1082.20	1.20	190.	1593.	5.75	15.75	0.00

INFLOW-OUTFLOW HYDROGRAPH
FOR THE PMF

Max. Inflow = 1871 cfs
Max. Outflow = 1593 cfs

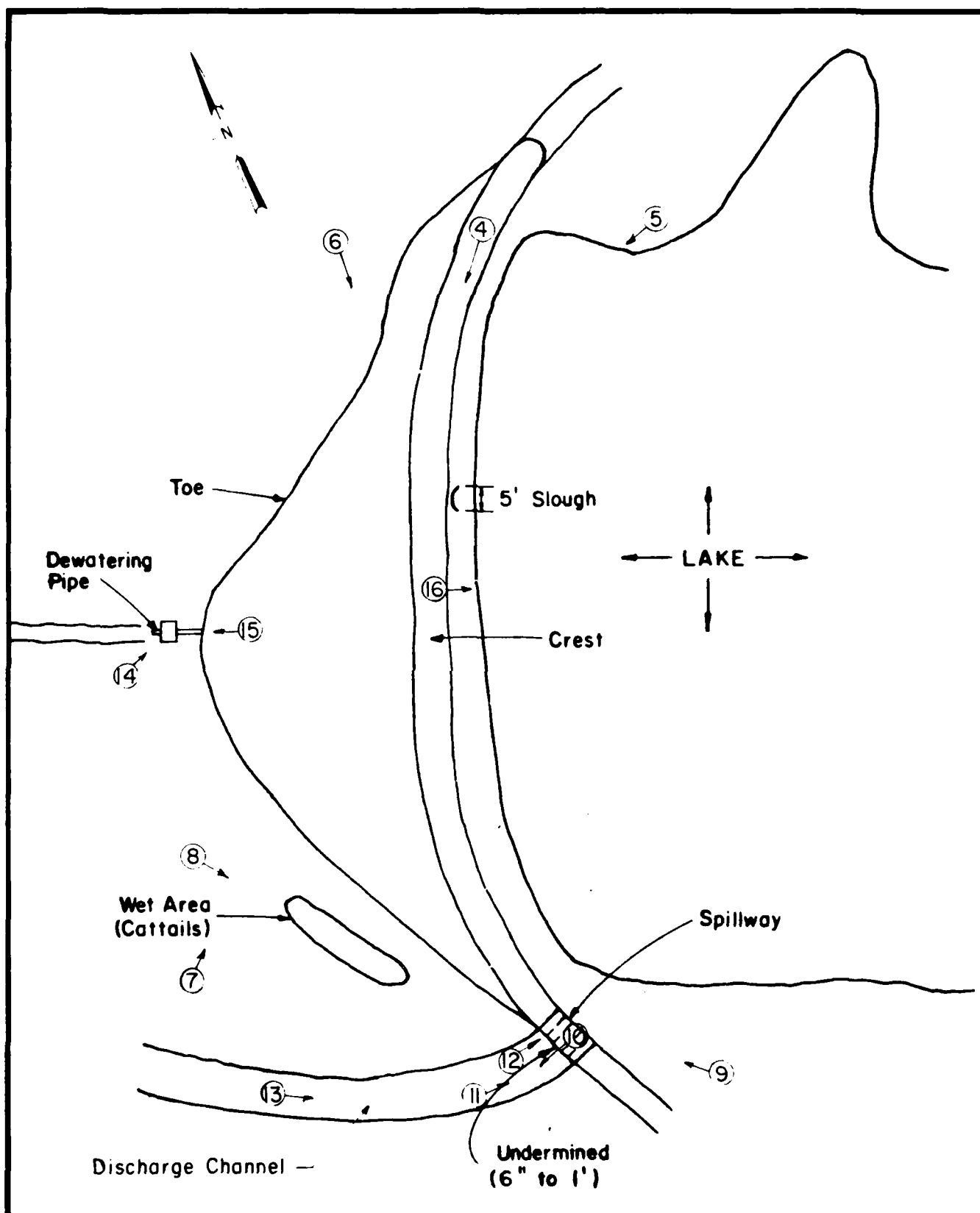


APPENDIX D

Photographs

INDEX TO PHOTOGRAPHS

<u>Photo No.</u>	<u>Description</u>
1.	Aerial view of lake from upper edge of watershed looking west.
2.	Aerial view of dam looking north.
3.	Aerial view of dam looking northeast.
4.	Crest of dam from right abutment looking southwest.
5.	Upstream face from right abutment looking southwest.
6.	Downstream face from right abutment looking south.
7.	Downstream face from right abutment looking northeast.
8.	Wet area near downstream toe in left abutment area.
9.	Spillway structure entrance at left abutment looking northwest.
10.	Spillway outlet channel looking downstream from top of spillway structure.
11.	Spillway structure outlet looking upstream.
12.	Undermining of spillway structure right side.
13.	Spillway outlet channel looking upstream.
14.	Draindown pipe outlet.
15.	Outlet channel draindown pipe looking downstream.
16.	View of lake from crest of dam.



PHOTOGRAPH LOCATIONS



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Scioto Dam
Phelps County, Missouri
Mo. I.D. No. 30097

Sheet 2, Appendix D

